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EP 0448833 A1
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(54) Abstract Title
Internally reinforced air springs

(57) Air spring 10 is reinforced internally at 15. The reinforcement means may be a wire coil; and may be separate from, or integral with, side wall 17. The reinforcement allows the air spring to be compacted and an associated vehicle wheel suspension to be withdrawn by using vacuum power, without the air spring suffering excessive inward collapse of side walls 17. The air spring may be moulded in concertina form (Figs. 2A, 2B), and may be used as an actuator in a known retractable suspension (Figs. 3 to 5), particularly for an amphibious vehicle; where the suspension may be used to withdraw road wheels above the hull water line. The suspension may also be used to increase ride height above normal road level. Numerals 12 and 13 denote conventional mounting members.

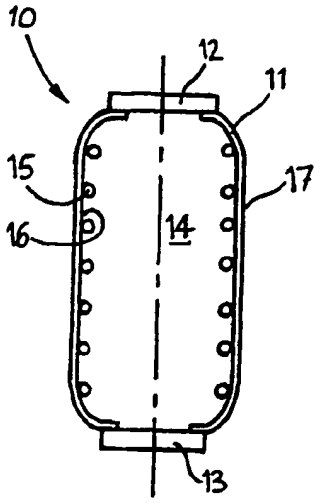

FIG. 1A

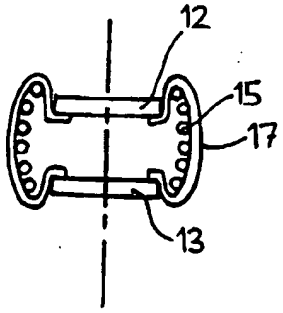

FIG. 1B

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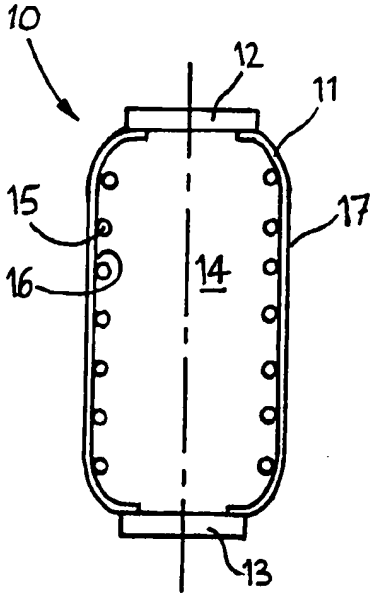

FIG. 1A

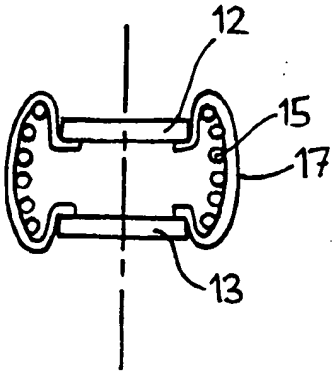

FIG. 1B

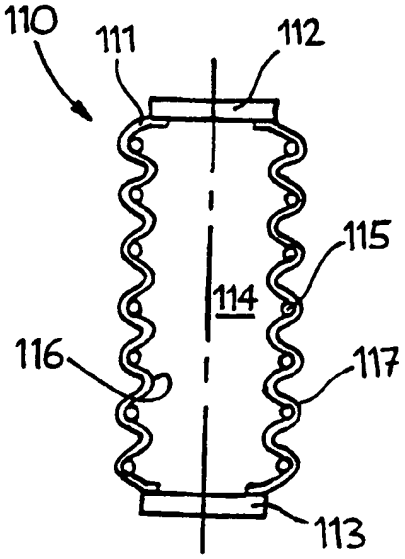

FIG. 2A

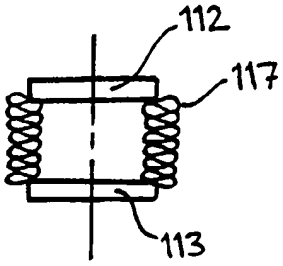

FIG. 2B

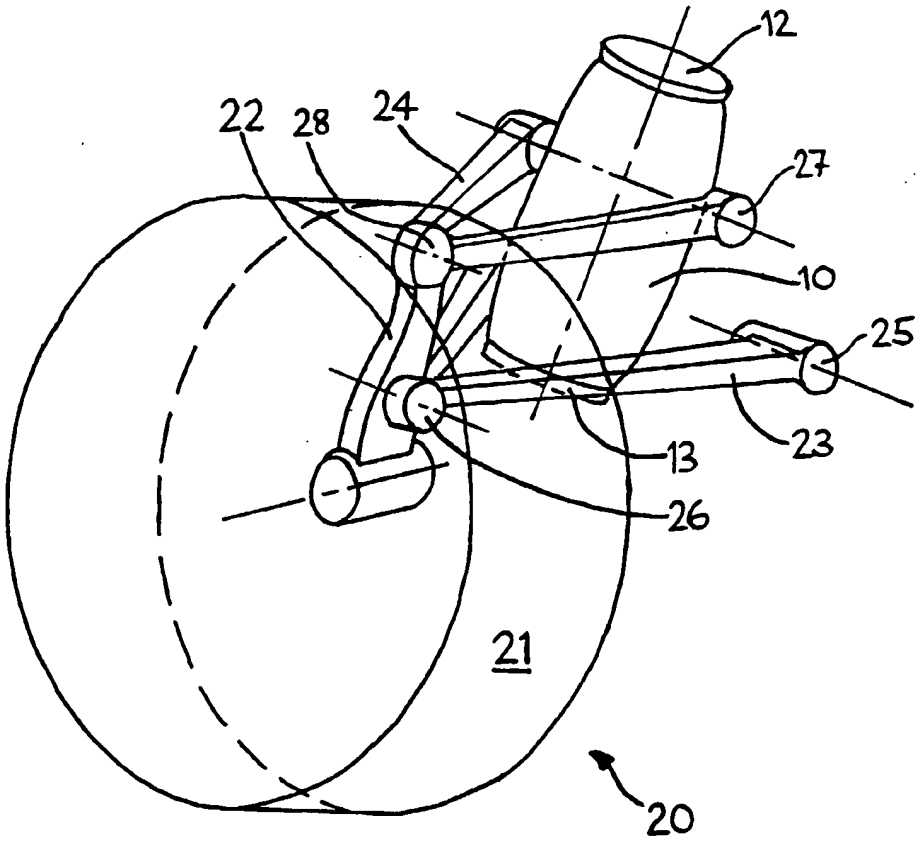

FIG.3

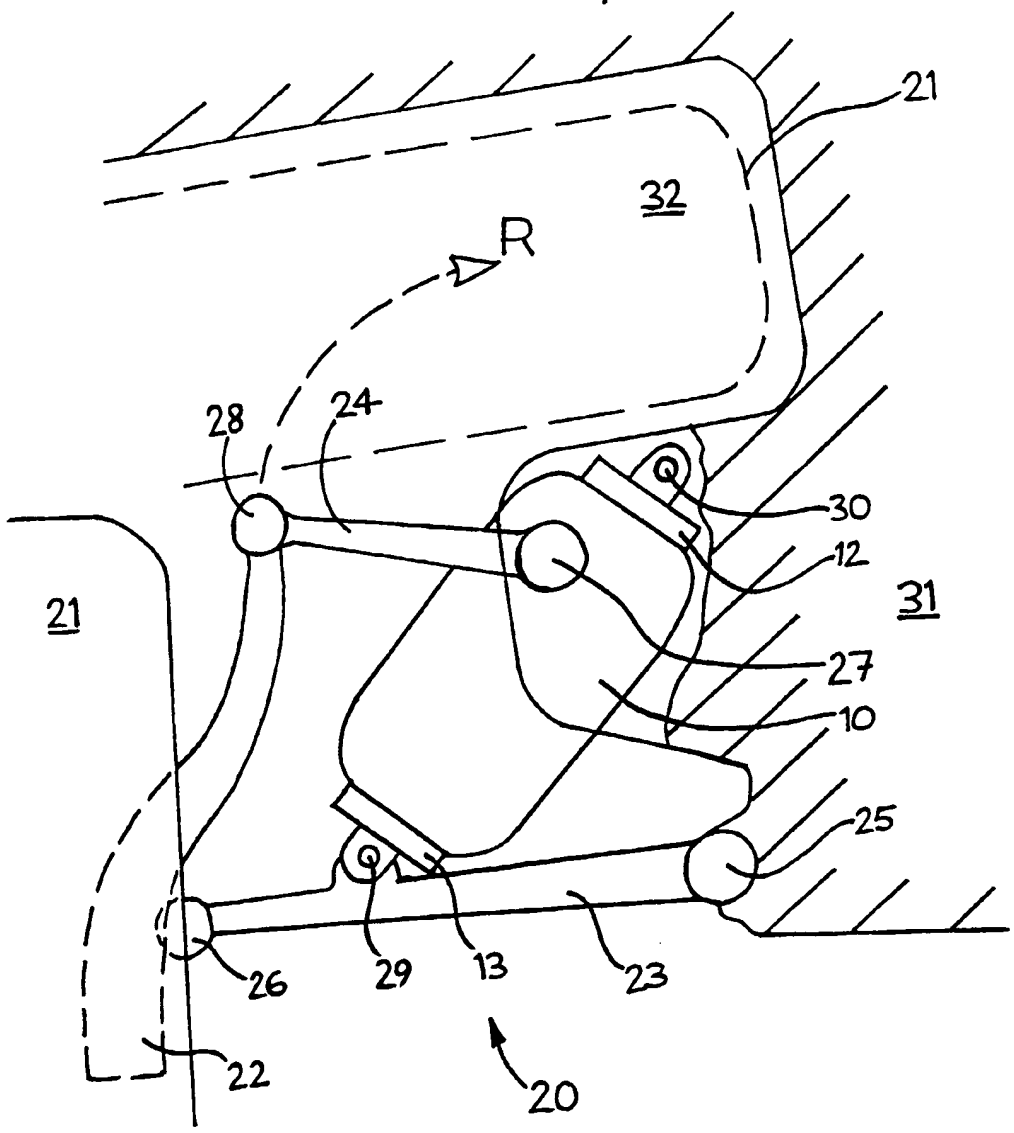

FIG. 4

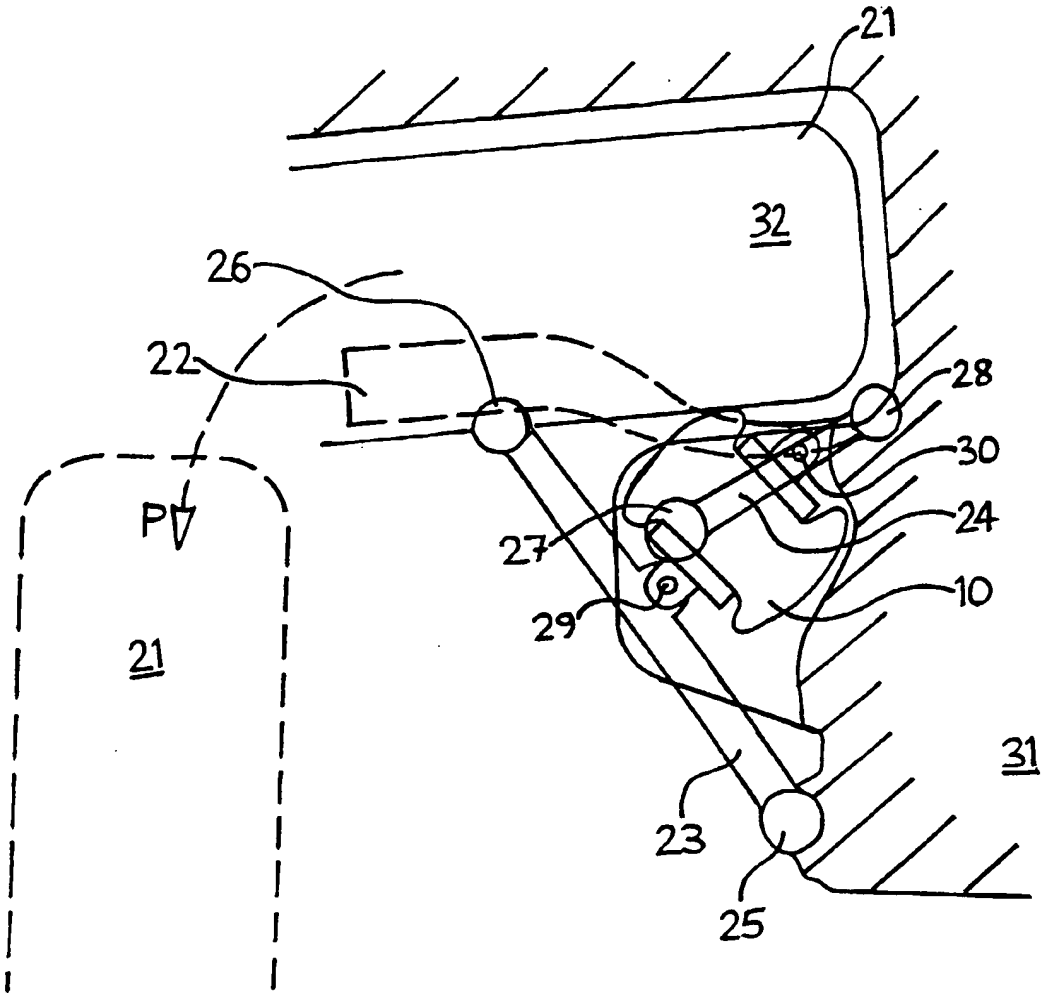

FIG.5

Air Springs

The present invention relates to air springs. In particular, though not exclusively, the invention relates to air springs which can be used on an amphibious vehicle to provide suspension for at least one wheel of the vehicle and also to move the at least one wheel between protracted and retracted positions.

It is known to use air springs to provide suspension for road-going vehicles. A known air spring comprises a flexible tube, which may be made of rubber or a similar material. Each end of the tube is hermetically connected to a respective mounting member. The spring is typically located by means of the mounting members between two relatively movable components of the vehicle such as an axle and a chassis member. The interior of the spring is selectively connectable to a source of pressurized air and means are provided to control the pressure of the air within the spring. In normal use the interior of the spring is maintained at a positive pressure which ensures that the flexible tube remains in tension and provides a suspensive effect to absorb road shocks.

In known air spring systems, the pressure of the air within the air springs on a vehicle is selected so as to maintain the vehicle at a required ride height for a given vehicle load. It is also known for the pressure within the springs to be adjustable so as to maintain vehicle at the required ride height despite the variations in the vehicle load. Thus, if the vehicle load increases the pressure of the air within the springs can be increased to compensate. Conversely, the pressure of the air within the springs can be decreased to compensate for a decrease in the vehicle load.

It is also known to use air springs to vary the ride height of a vehicle. For example, it is known in buses to decrease the air pressure in the springs on one side of the vehicle when the bus stops. This has the effect of lowering of that side of the vehicle thereby helping elderly or handicapped people to get on and off.

Amphibious vehicles which provide for powered travel on both land and on water are also known. In certain known amphibious vehicles, the wheels of the vehicle are connected to the vehicle body by suspension assemblies adapted to enable the wheels to be moved from a protracted position, in which they support the vehicle for land use, to a retracted position, in which the wheels are moved above the water line for use of the vehicle in water. Such an amphibious vehicle is known for example from European patent No. EP 0 742 761. In such known arrangements, the suspension assemblies usually comprise a spring means for absorbing road shocks. The assemblies also comprise an actuator means for moving the suspension assemblies and the wheels from the protracted position to the retracted position to convert the vehicle for use on water.

It is an object of the present invention to provide an improved air spring.

It is also an object of the present invention to provide an air spring which can be used both as a spring to absorb road shocks and as an actuator.

It is a further object of the present invention to provide an improved method of operating an air spring.

It is a still further objective of the invention to provide an amphibious vehicle having an improved air spring which can be used as a conventional air spring and also as an actuator to move a wheel and suspension assembly from a protracted position to a retracted position.

Thus, in accordance with a first aspect of the invention, there is provided an air spring comprising a flexible tube member connected at either end to a respective mounting member, the air spring further comprising internal reinforcement means associated with the flexible tube member, which internal reinforcement means substantially prevents or limits inward collapse of the side wall of the flexible tube.

In an air spring in accordance with the first aspect of the invention, it is possible to evacuate some or all of the air within the air spring since the internal reinforcement means

prevents, or at least limits, the inward collapse of the side wall of the flexible tube. With such an arrangement the working stroke of the spring can be increased and it is possible to use the spring as an actuator to apply a pulling force between two components attached to the spring when the air in the spring is evacuated.

In a preferred embodiment the internal reinforcement means comprises a wire coil or similar arrangement.

In accordance with a second aspect of the invention, there is provided a method of operating an air spring, which air spring comprises a flexible tube member connected at either end to a respective mounting member, the method comprising the steps of:

providing an internal reinforcement means to substantially prevent or limit inward collapse of the side wall of the tube; and

evacuating all or some of the air from the interior of the spring.

A method of using an air spring in accordance with the second aspect of the invention permits use of the air spring over an increased working stroke. It also allows the air spring to be used as an actuator to apply a pulling force between two components attached to the spring when the air within the spring is evacuated.

In accordance with a third aspect of the invention there is provided an amphibious vehicle having at least one wheel connected to a body of the vehicle by a suspension assembly which is adapted to enable the wheel to be moved from a protracted position to a retracted position, the suspension assembly further comprising an air spring constructed in accordance with the first aspect of the invention or operated in accordance with the method of the second aspect of the invention, the arrangement being such that the air within the spring can be evacuated to move the at least one wheel from the protracted position to the retracted position.

Several embodiments of the invention will now be described, by way of example only, with reference to the following drawings in which:

Figures 1A and 1B are simplified, somewhat schematic views in cross section of a first embodiment of an air spring in accordance with the invention showing the spring in a fully extended condition and fully contracted condition respectively;

Figures 2A and 2B are views similar to that of Figures 1A and 1B but showing a second embodiment of an air spring in accordance with the invention;

Figure 3 is a perspective view of a simplified wheel and suspension assembly for an amphibious vehicle, the assembly comprising an air spring in accordance with the invention;

Figure 4 is a front view of the suspension assembly of Figure 3 showing the assembly in a protracted position with the air spring in land travel mode; and,

Figure 5 is a view similar to that of Figure 4 showing the wheel and suspension assembly in a retracted position with the air spring fully contracted.

Figures 1A and 1B show an air spring indicated generally at 10. The spring 10 comprises a flexible tube member 11 which is connected at either end to a respective mounting member 12, 13. The tube member may be made of any suitable material but preferably is made of rubber, synthetic rubber or a similar material and the connection between the ends of the tube and the mounting members 12, 13 is hermetically sealed.

The spring 10 further comprises an internal reinforcement means 15 which is associated with the inner surface 16 of the side wall 17 of the tube member to limit inward movement of the side wall 17 of the tube. The reinforcement member 15 may take any suitable form but in the embodiment shown is in the form of a wire coil.

The reinforcement means 15 may be a separate component arranged to contact the inner surface 16 of the side wall 17 of the tube member 11 as shown. Alternatively, the reinforcement means could be provided as an integral component of the tube member.

The interior 14 of the tube 11 is selectively connectable via valve means (not shown) to a source of pressurized air or to a source of vacuum such that the pressure of the air within the tube can be controlled. When the interior of the tube 14 is connected to a source of vacuum, the air within the tube can be exhausted resulting in the pressure of the air inside the spring being lower than the ambient pressure outside the spring, in other words the interior 14 of the spring can be subjected to a negative air pressure.

Figures 2A and 2B show a second embodiment of an air spring 110 which is similar to the spring 10 shown in Figures 1A and 1B. The same reference numerals but increased by 100 are used to identify components which perform the same function as those described above with reference to the spring 10 shown in Figures 1A and 1B.

The spring 110 is identical to the spring 10 in all respects except for the construction of the tube member 111 which is formed as a concertina or bellows. The concertina or bellows construction of the tube member 111 allows the spring 110 to operate over a larger range of movement than the spring 10. This can be advantageous when using the spring 110 as an actuator, as will be described in more detail later.

Operation of the springs 10, 110 will now be described. Since the operation of spring 110 is identical to that of spring 10, the following description will refer only to spring 10. It should be understood, however, that the following description applies equally to spring 110.

Figure 1A shows the spring 10 in operation as a conventional air spring. The interior 14 of the spring is subject to a positive air pressure maintaining the tube member 11 in tension and biasing the mounting members 12, 13 apart. In use the mounting members 12, 13 will be attached to relatively moveable components of a vehicle, such as the body of the vehicle

and a suspension linkage respectively. When a wheel attached to the suspension linkage goes over a bump, this will result in a relative movement between the suspension linkage and the body of the vehicle which tends to compress the air within the spring 10. Compression of the air within the spring acts to absorb the shock of the wheel hitting the bump and so reduces the shock which is transferred to the body of the vehicle.

Figure 1B shows the spring 10 in a fully contracted position with all, or at least most, of the air within the spring evacuated. The mounting members 12, 13 have been drawn together, with the movement of the mounting members towards each other being greater than would occur during use of the spring 10 as a conventional air spring. Despite the negative air pressure within the tube member 11, the side wall 17 is prevented from collapsing inwards by the wire coil 15. This arrangement allows proper operation of the air spring over its full range of movement from the extended position shown in Figure 1A to the contracted position shown in Figure 1B.

Evacuation of the air from within the tube 11 allows the spring 10 to be used as an actuator to apply a pulling force between two components to which the mounting members are attached. So in the example described above where the spring is mounted between a suspension member and a vehicle body, the spring 10 can be evacuated in order to apply a pulling force between the body of the vehicle and the suspension linkage. This will tend to move the linkage relative to the vehicle body. If the interior of the spring is subsequently re-pressurized, the mounting members 12, 13 will be forced apart by the pressure of the air within the spring 10 and will tend to move the linkage member back in the opposite direction.

This arrangement has particular application in an amphibious vehicle having wheels that can be moved from a protracted position, in which the wheels support the vehicle body for normal road or land use, to a retracted position, in which the wheels are moved above the water line for use of the vehicle in water. An amphibious vehicle of this type is described in European Patent No. EP 0 742 761 to which the reader should refer for a more detailed description of the wheel retraction arrangement.

Figures 3 to 5 show a simplified suspension assembly 20 for an amphibious vehicle having a retractable wheel 21.

The wheel 21 is attached to a vehicle body 31 by the suspension assembly 20 which comprises a wheel upright support 22, a lower suspension arm 23 and an upper suspension arm 24. The upper and lower suspension arms 23, 24 both have a generally V or wishbone shape. The inner ends of the lower suspension arm 23 are pivotally attached to the vehicle body at mounting points 25 whilst the outer end is pivotally attached to the wheel upright support at the mounting point 26. Similarly, the inner ends of the upper suspension arm 24 are pivotally attached to the vehicle body at mounting points 27, whilst the outer end is pivotally mounted to the wheel upright support 22 at mounting point 28.This arrangement permits movement of the wheel 21 relative to the vehicle body as for example when the wheel goes over a bump in the road or during wheel retraction as will be described later.

An air spring 10 in accordance with the invention is mounted to the vehicle body 31 at point 30 and to the lower suspension arm 23 at mounting point 29. The spring 10 can be operated in a land travel mode of the vehicle as a conventional air spring with the interior of the spring being pressurized from a source of pressurized air (not shown). In this mode of operation, the air spring 10 acts to absorb road shocks as the wheel 21 travels over bumps on the road or land surface.

In normal land use, the pressure of the air within the spring is controlled so as to maintain the vehicle at the correct ride height. However, if required, the pressure in the air spring 10 could be varied in order to vary the ride height of the vehicle. For example, the pressure in the spring could be raised to increase the ride height and thereby provide more ground clearance when the vehicle travels over rough terrain.

The spring 10 can also be used as an actuator to move the wheel between its protracted and retracted positions so as to change the vehicle from land use mode to water use mode and vice versa. In order to move the wheel from the protracted to the retracted position, the interior of the spring is connected to a source of vacuum to exhaust the air from inside the

spring. This results in the mounting members 12, 13 being drawn together so that the lower suspension arm 23 is pivoted upwardly, according to arrow R, moving the wheel to the retracted position.

Figures 3 and 4 show the spring and suspension assembly in land travel mode. In Figure 4, the position of the wheel 21 in the protracted position is indicated by solid lines whilst the position of the wheel when retracted is shown by dashed lines.

Figure 5 shows the spring 10 in its fully contracted condition. In this Figure, the position of the wheel 21 when fully retracted is indicated by solid lines whilst the position of the wheel when in the protracted position is indicated by dashed lines.

It should be noted that mounting points 25, 27 and 30 are fixed on the vehicle body. During wheel retraction, arm 23 and wheel support 22 are pivoted upwards, causing arm 24 to rotate around mounting point 27 in an "over centre" action, as disclosed in EP 0 742 761, so that in the fully retracted position, joint 28 is found inboard of mounting 27.

When it is desired to return the wheel 21 to its protracted position, the spring 10 can be re-pressurized by again connecting it to the source of pressurized air so that the mounting members 12, 13 are biased apart and the lower suspension arm 23 is pivoted downwardly according to arrow P until the wheel 21 is once again in its protracted position for land use. The spring 10 can then be operated as a conventional air spring once more.

Although the above description referred to an air spring 10, as shown in Figures 1A and 1B, it will be understood that the air spring could be of any suitable design and in particular may be of the type shown in Figures 2A and 2B in which the tube member 111 is of concertina or bellows form. The advantage of using a spring 110 of the concertina or bellows type is that the spring can operate over an extended range of movement which may be required in order to move the wheel between the protracted and retracted positions. Indeed it should be noted that air springs in accordance with the invention when used in the manner described above in relation to an amphibious vehicle will typically have a longer

stroke than would be provided in a conventional air spring. The longer stroke being necessary in order to provide the required range of movement for moving the wheel between the protracted and retracted positions.

It can be seen that an air spring in accordance with the present invention can advantageously be used to provide a dual function as a spring means and as an actuator for an amphibious vehicle having a retractable wheel system. Furthermore, because the reinforcement means 15, 115 is provided internally, it is not subject to corrosion in a salt water environment.

Claims

1. An air spring comprising a flexible tube member connected at either end to a respective mounting member, the air spring further comprising internal reinforcement means associated with the flexible tube member, which internal reinforcement means substantially prevents or limits inward collapse of the side wall of the flexible tube.

2. An air spring in accordance with claim 1 in which the internal reinforcement means comprises a wire coil.

3. An air spring in accordance with claim 1 or claim 2 in which the reinforcement means is a separate component placed in contact with the inner surface of the tube member.

4. An air spring in accordance with claim 1 or claim 2 in which the reinforcement means is formed as an integral component of the tube member.

5. An air spring in accordance with any previous claim in which the interior of the spring is selectively connectable to a source of pressurized air or to a source of vacuum.

6. An air spring substantially as hereinbefore described with reference to and as shown in Figures 1A and 1B, or Figures 2A and 2B of the accompanying drawings.

7. A method of operating an air spring, which air spring comprises a flexible tube member connected at either end to a respective mounting member, the method comprising the steps of:

providing an internal reinforcement means to substantially prevent or limit inward collapse of the side wall of the tube; and

evacuating substantially all or some of the air from the interior of the spring such that the interior of the spring is subjected to a negative air pressure.

8. A method in accordance with claim 7, the method comprising the further step of connecting the spring between two relatively moveable components such that the spring applies a pulling force between the two components when the air within the spring is evacuated.

9. A method of operating an air spring substantially as hereinbefore described and as illustrated with reference to the accompanying drawings.

10. An amphibious vehicle having at least one wheel connected to a body of the vehicle by a suspension assembly which is adapted to enable the wheel to be moved from a protracted position to a retracted position, the suspension assembly further comprising an air spring constructed in accordance with any one of claims 1 to 6 or operated in accordance with the method of claims 7 to 9, the arrangement being such that air within the spring can be evacuated so as to move the at least one wheel from the protracted position to the retracted position.

11. An amphibious vehicle having a suspension assembly substantially as hereinbefore described, with reference to and as shown in Figures 3 to 5 of the accompanying drawings.

INVESTOR IN PEOPLE

Application No: GB 0104929.5
Claims searched: 1 to 11

Examiner: Colin Thompson
Date of search: 16 July 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): F2S (SBD, SBN); B7A (ABA)

Int Cl (Ed.7): F16F 9/04; B60F 3/00

Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2153483 A	(Dunlop Ltd) See Fig 1	1,2,4
X	GB 2142707 A	(Continental Gummi-Werke AG) See Fig 2	1,4
X	GB 2046872 A	(Continental Gummi-Werke AG) See Fig 1	1,4
X	GB 259603 A	(Monge) See whole document	1-3,7
X	EP 0448833 A1	(Continental AG) See whole document	1,2,4
X	WO 97/07999 A1	(Lee) See Fig 2	1-3

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.